

Tile Surface Thermocouple Measurement Challenges from the Orbiter Boundary Layer Transition Flight Experiment

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Hypersonic entry flight testing motivated by efforts seeking to characterize boundary layer transition on the Space Shuttle Orbiters have identified challenges in our ability to acquire high quality quantitative surface temperature measurements versus time. Five missions near the end of the Space Shuttle Program implemented a tile surface protuberance as a boundary layer trip together with tile surface thermocouples to capture temperature measurements during entry. Similar engineering implementations of these measurements on *Discovery* and *Endeavor* demonstrated unexpected measurement voltage response during the high heating portion of the entry trajectory. An assessment has been performed to characterize possible causes of the issues experienced during STS-119, STS-128, STS-131, STS-133 and STS-134 as well as similar issues encountered during other orbiter entries.

I. Abstract/Summary

ORBITER entry flight testing conducted during the last several years of the Space Shuttle Program has raised our awareness of potential challenges associated with tile based surface thermocouple measurements. Flight based hypersonic entry measurements provide a critical link in the path of certifying entry vehicle Thermal Protection systems (TPS) for flight, and provide the basis for ground to flight extrapolation and flight data validation of modeling capabilities. Multiple flights of the Orbiter Boundary layer Transition Flight Experiment (BLT FE) exhibited issues during the hypersonic heating portion of entry that have qualitatively similar characteristics. Studies of historical orbiter entry data illustrate that these issues have been occurring for the duration of the Shuttle Program, albeit with smaller discrepancies than those experienced during the BLT FE. A description of the qualitative features of the tile thermocouple issues encountered during the BLT FE will be developed. In addition, the results of an assessment to evaluate potential causes will be described together with a qualitative perspective on the likelihood of each cause. This information will be described in the form of a fishbone assessment, which is used to develop a list of potential causes in order to facilitate closure of individual causes, thus enabling planning associated with establishing one or more most likely causes.

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